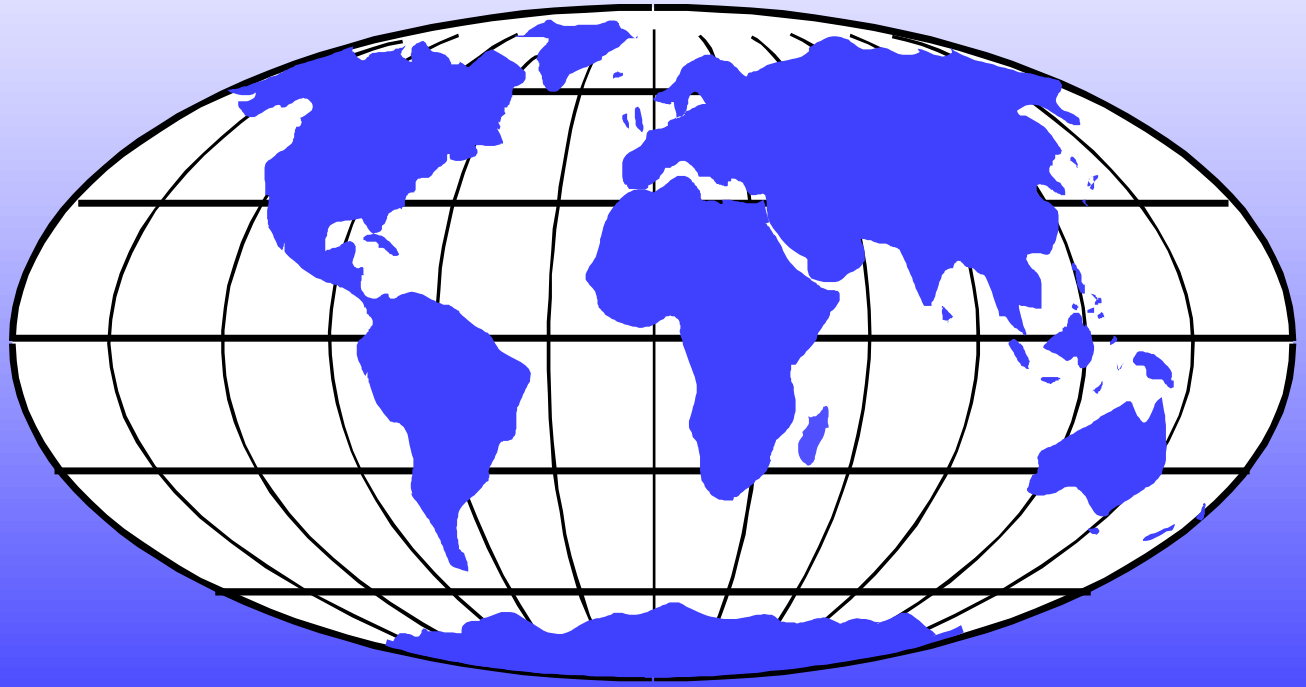
# INTERACTIVE PRESENTATION ON KEY TREND FOR ADVANCED TECHNOLOGIES AND ROLE OF SOI (OCTOBER 14, 2013)



**INTERNATIONAL BUSINESS STRATEGIES, INC.**
632 Industrial Way | Los Gatos CA 95030 | USA | 408 395 9585 | 408 395 5389 (fax)
www.ibs-inc.net | info@ibs-inc.net

# INTERNATIONAL BUSINESS STRATEGIES BACKGROUND

IBS

- Has been in business for 25 years
- Previous experience in managing 1.5K+ engineers at Rockwell International, which included avionics, communications, and semiconductors. Also head of strategy and business development
- Interface with most global leaders in electronics industry. Customers are in U.S., Europe, South Korea, Japan, Taiwan, China, India, etc
- Interface and support major global corporations, eg, IBM, GE, Intel, Qualcomm, Microsoft, Nokia, Samsung, Apple, Cisco, Cadence, Synopsys, Mentor Graphics, ASML, Fujitsu, Sony, Toshiba, Canon, Renesas Electronics, TSMC, SMIC, STMicroelectronics, NXP Semiconductors, TI, and others
- Interface and support financial institutions, eg, Carlyle, Blackstone, CitiGroup, Warburg Pincus, Walden, KKR, Morgan Stanley, Bain Capital, Bank of America, TPG, and others
- Participated with French government on their advanced technology initiatives for Nano 2017
- Involved in wide range of activities in China

  Wrote business book “Chinamerica” (published by McGraw Hill). Forbes blog contributor. Wrote China Daily articles, Global Times editorials, etc
- Active in Japan, and close relationship with many Japanese companies

  Wrote editorial articles for Nikkei Weekly, including:
  - “Why Japan Must Have a Strong Semiconductor Industry” (published on December 24, 2012)
  - “A Dozen Problems Plaguing Corporate Japan” (published on December 19, 2011)

**IBS HAS HIGH MARKET SHARE OF TECHNOLOGY AND STRATEGY BUSINESS GLOBALLY BUT HAS LOW PROFILE BECAUSE OF HIGH CONFIDENTIALITY LEVELS OF PROJECTS**

# TOP-LEVEL FACTORS IN SEMICONDUCTOR INDUSTRY

IBS

- Multimedia mobile platforms (smartphones and tablets) are driving growth of IC market in 2013

  Very high growth in China, but with global supply chains for semiconductor products

  Need low power and low cost
- Personal computer market is down and likely to remain soft for next 24 to 36 months

  Increased convergence between tablet computers and notebook computers
- Cloud computing and communications infrastructure will have strong growth but relatively low percentage of total IC market

  Driver for high speed interfaces
- Automotive is in steady growth phase, with global supply. China market is strong
- Television market is down, but 4K will have high growth

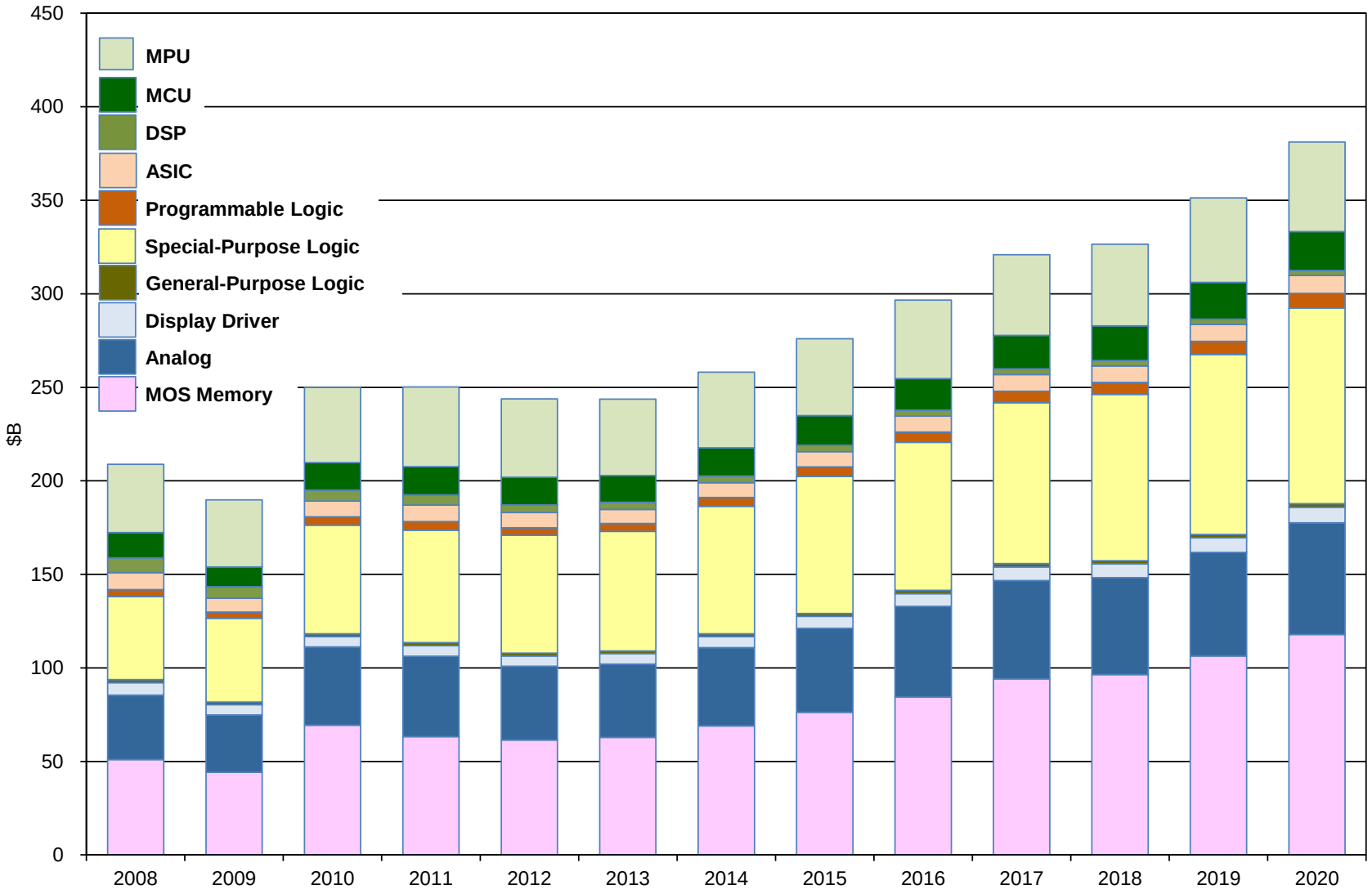
  DTV IC market is dominated by MStar-MediaTek
- Medical electronics will be large market in future but has many regulatory issues

  Will involve wide range of technologies, including RF, MEMS sensors, and signal processing
- RF is in high growth and has many segments
- MEMS is in strong growth mode and is highly fragmented
- Growth of semiconductor market will  be stronger in 2014 than in 2013

**MANY OPPORTUNITIES WITHIN SEVERAL AREAS OF SPECIALTY TECHNOLOGIES**

# IC MARKET BY PRODUCT

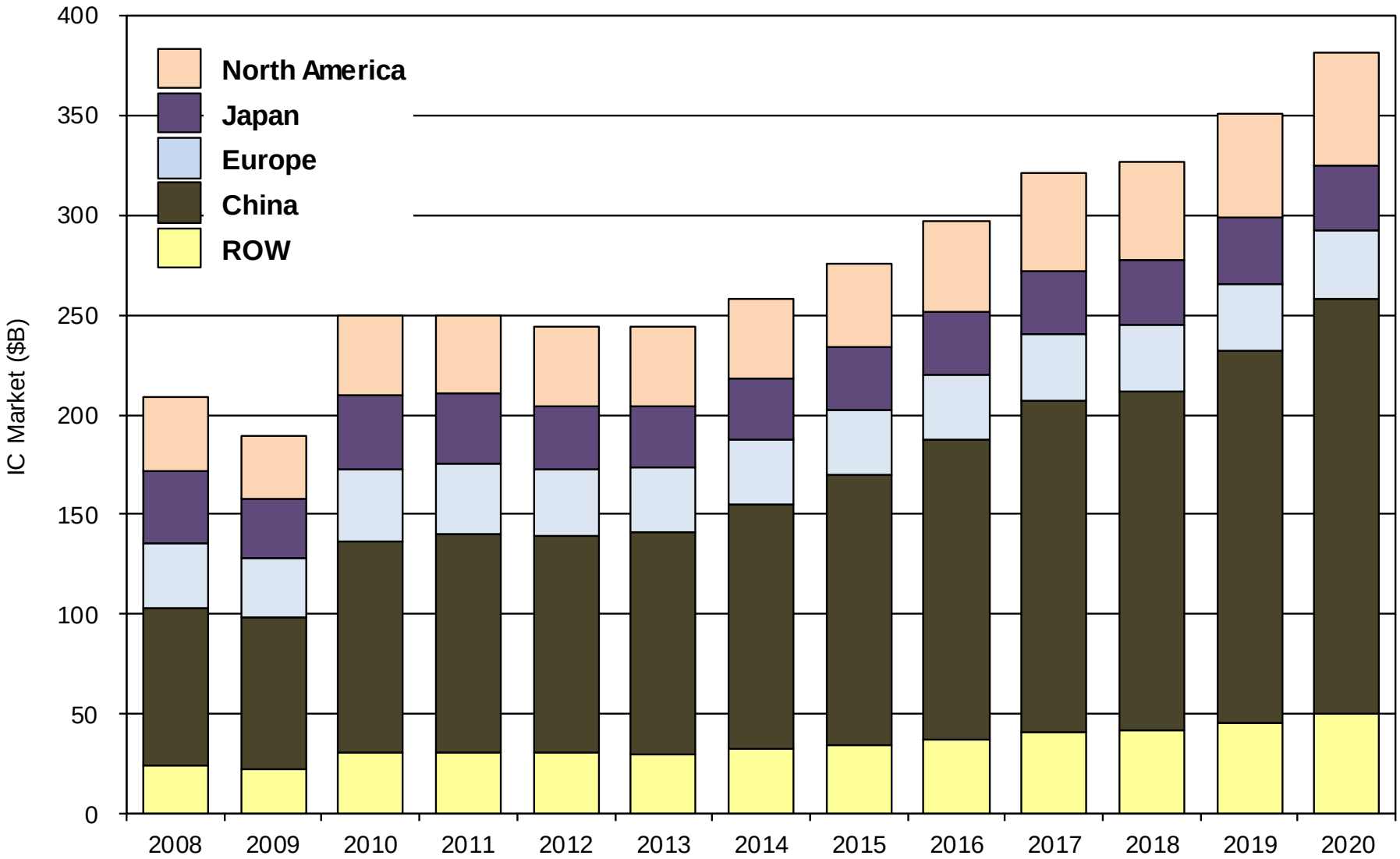
IBS




## STEADY GROWTH THROUGH 2020

# IC MARKET BY GEOGRAPHY

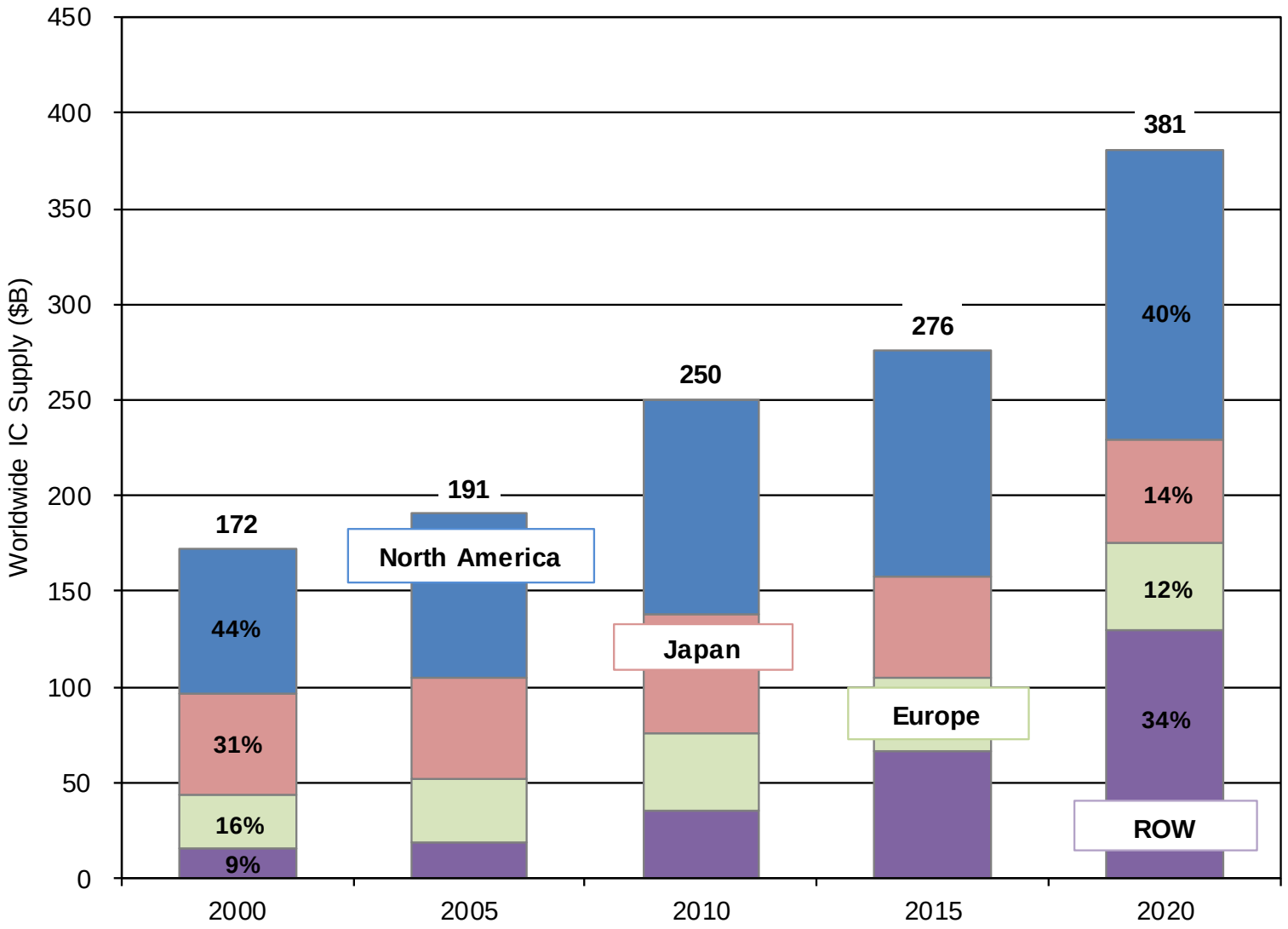
IBS




**COMPOSITION OF MARKET IS CHANGING**

# IC SUPPLY BY GEOGRAPHY

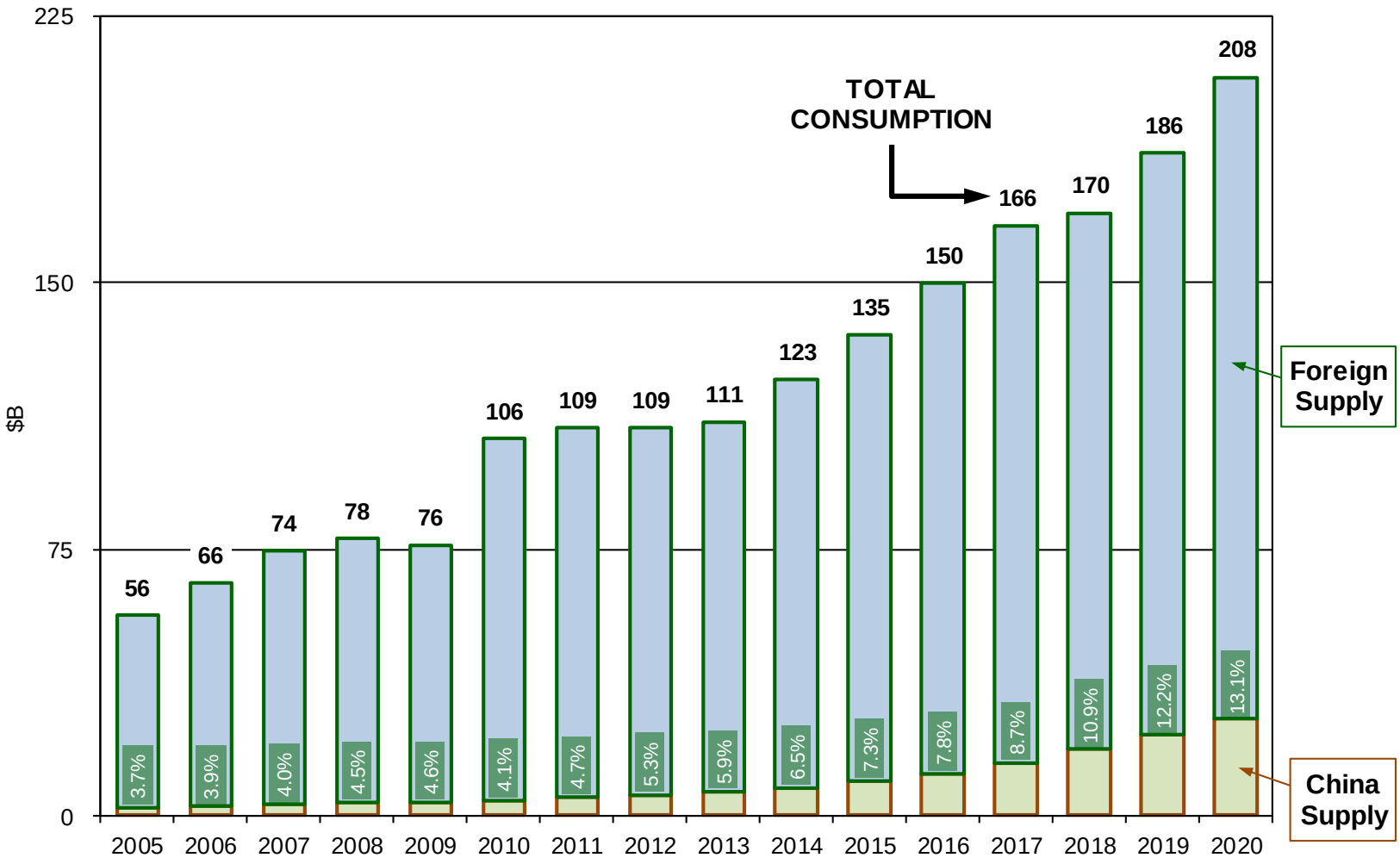
IBS




## SUPPLY BASE IS CHANGING, AND ROW HAS HIGH GROWTH

# IC CONSUMPTION IN CHINA

IBS

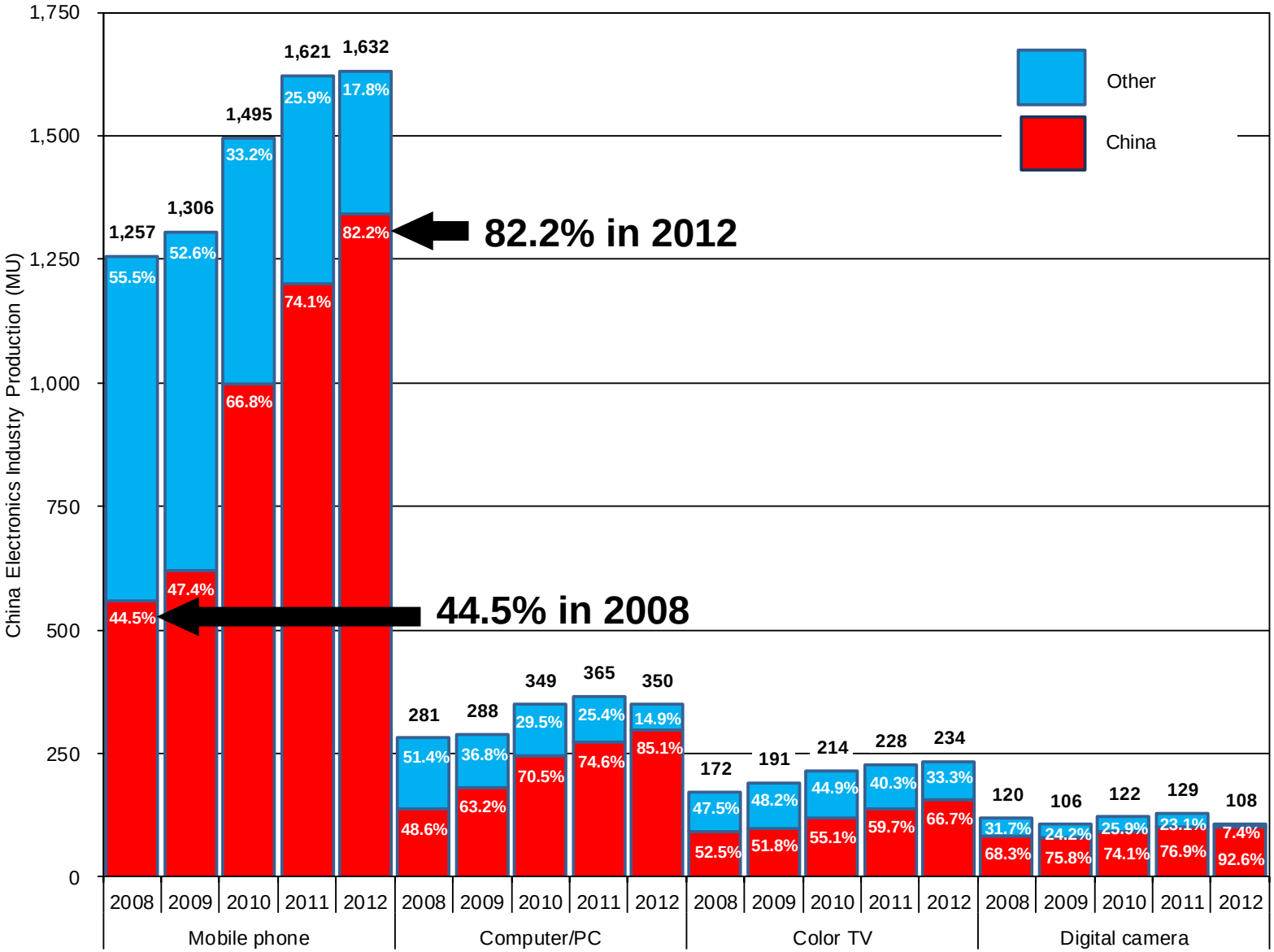



**MANY OPPORTUNITIES TO SELL INTO CHINA MARKET**

**ADVANTAGEOUS TO BE PART OF CHINA'S SUPPLY CHAIN**

# CHINA'S ELECTRONICS INDUSTRY PRODUCTION

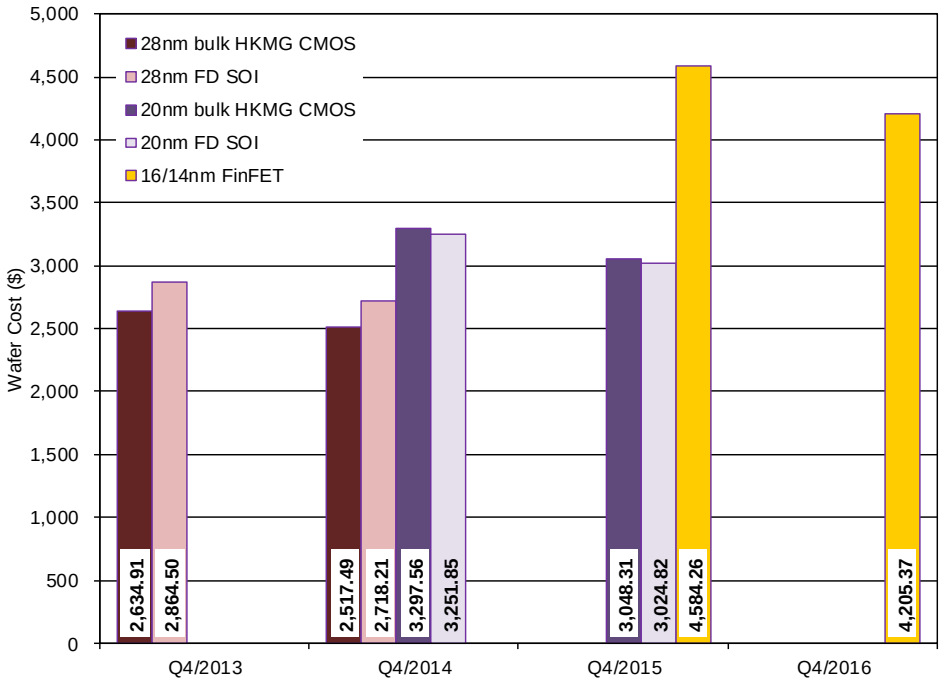
IBS



# WAFER COST COMPARISON

IBS

| ($) | Q4/2013 | Q4/2014 | Q4/2015 | Q4/2016 |
|---|---|---|---|---|
| 28nm bulk HKMG CMOS | 2,634.91 | 2,517.49 | -- | -- |
| 28nm FD SOI | 2,864.50 | 2,718.21 | -- | -- |
| 20nm bulk HKMG CMOS | -- | 3,297.56 | 3,048.31 | -- |
| 20nm FD SOI | -- | 3,251.85 | 3,024.82 | -- |
| 16/14nm FinFET | -- | -- | 4,584.26 | 4,205.37 |




**FD SOI IS COST COMPETITIVE AT 28nm, WITH COST ADVANTAGE AT 20nm**

# 28nm BULK HKMG CMOS WAFER COST

IBS

| | Q4/2013 | | Q4/2014 | |
|---|---|---|---|---|
| | $ | % | $ | % |
| Depreciation | 1,469.54 | 56.36 | 1,376.90 | 55.22 |
| Equipment maintenance | 370.48 | 14.21 | 351.91 | 14.11 |
| Direct labor | 35.51 | 1.36 | 35.53 | 1.43 |
| Indirect labor | 164.65 | 6.31 | 163.63 | 6.56 |
| Facilities | 156.42 | 6.00 | 153.06 | 6.14 |
| Wafer cost | 128.95 | 4.95 | 129.97 | 5.21 |
| Consumables | 262.83 | 10.08 | 263.60 | 10.57 |
| Monitor wafers | 19.13 | 0.73 | 18.71 | 0.75 |
| TOTAL Unyielded wafer cost | 2,607.51 | 100.00 | 2,493.32 | 100.00 |
| Line yield (%) | 98.96 | -- | 99.04 | -- |
| TOTAL Yielded wafer cost | 2,634.91 | -- | 2,517.49 | -- |
| Wafer price - 45% GPM ($) | 4,790.75 | -- | 4,577.25 | -- |

**IN HIGH VOLUME PRODUCTION**

# 28nm FD SOI WAFER COST

IBS

| | Q4/2013 | | Q4/2014 | |
|---|---|---|---|---|
| | $ | % | $ | % |
| Depreciation | 1,371.85 | 48.96 | 1,283.41 | 47.93 |
| Equipment maintenance | 353.42 | 12.61 | 323.76 | 12.09 |
| Direct labor | 33.76 | 1.20 | 32.21 | 1.20 |
| Indirect labor | 142.64 | 5.09 | 140.93 | 5.26 |
| Facilities | 131.45 | 4.69 | 128.34 | 4.79 |
| Wafer cost | 500.00 | 17.85 | 500.00 | 18.67 |
| Consumables | 247.35 | 8.83 | 248.14 | 9.27 |
| Monitor wafers | 21.30 | 0.76 | 20.92 | 0.78 |
| TOTAL Unyielded wafer cost | 2,801.77 | 100.00 | 2,677.71 | 100.00 |
| Line yield (%) | 97.81 | -- | 98.51 | -- |
| TOTAL Yielded wafer cost | 2,864.50 | -- | 2,718.21 | -- |
| Wafer price - 45% GPM ($) | 5,208.19 | -- | 4,942.20 | -- |

**COST COMPETITIVE WITH BULK**

# 20nm BULK HKMG CMOS WAFER COST

IBS

| | Q4/2014 | | Q4/2015 | |
|---|---|---|---|---|
| | $ | % | $ | % |
| Depreciation | 1,822.20 | 57.35 | 1,654.19 | 55.78 |
| Equipment maintenance | 452.48 | 14.24 | 429.05 | 14.47 |
| Direct labor | 43.73 | 1.38 | 41.69 | 1.41 |
| Indirect labor | 208.88 | 6.57 | 203.07 | 6.85 |
| Facilities | 181.83 | 5.72 | 176.03 | 5.94 |
| Wafer cost | 128.19 | 4.03 | 128.33 | 4.33 |
| Consumables | 312.40 | 9.83 | 307.86 | 10.38 |
| Monitor wafers | 27.49 | 0.87 | 25.48 | 0.86 |
| TOTAL Unyielded wafer cost | 3,177.20 | 100.00 | 2,965.70 | 100.00 |
| Line yield (%) | 96.35 | -- | 97.29 | -- |
| TOTAL Yielded wafer cost | 3,297.56 | -- | 3,048.31 | -- |
| Wafer price - 45% GPM ($) | 5,995.56 | -- | 5,542.38 | -- |

**HIGH LEAKAGE, WHICH IMPACTS PRODUCT YIELDS**

# 20nm FD SOI WAFER COST

IBS

| | Q4/2014 | | Q4/2015 | |
|---|---|---|---|---|
| | $ | % | $ | % |
| Depreciation | 1,572.64 | 49.79 | 1,426.31 | 48.07 |
| Equipment maintenance | 387.36 | 12.26 | 352.49 | 11.88 |
| Direct labor | 42.85 | 1.36 | 41.37 | 1.39 |
| Indirect labor | 185.72 | 5.88 | 181.45 | 6.12 |
| Facilities | 146.75 | 4.65 | 142.34 | 4.80 |
| Wafer cost | 500.00 | 15.83 | 500.00 | 16.85 |
| Consumables | 293.75 | 9.30 | 294.17 | 9.91 |
| Monitor wafers | 29.78 | 0.94 | 28.92 | 0.97 |
| TOTAL Unyielded wafer cost | 3,158.85 | 100.00 | 2,967.05 | 100.00 |
| Line yield (%) | 97.14 | -- | 98.09 | -- |
| TOTAL Yielded wafer cost | 3,251.85 | -- | 3,024.82 | -- |
| Wafer price - 45% GPM ($) | 5,912.46 | -- | 5,499.68 | -- |

**COMPELLING TECHNOLOGY**

# 16/14nm FINFET WAFER COST

IBS

| | Q4/2015 | | Q4/2016 | |
|---|---|---|---|---|
| | $ | % | $ | % |
| Depreciation | 2,480.40 | 58.46 | 2,322.58 | 57.97 |
| Equipment maintenance | 626.81 | 14.77 | 587.37 | 14.66 |
| Direct labor | 65.16 | 1.54 | 62.23 | 1.55 |
| Indirect labor | 293.04 | 6.91 | 280.40 | 7.00 |
| Facilities | 229.51 | 5.41 | 220.38 | 5.50 |
| Wafer cost | 138.84 | 3.27 | 135.94 | 3.39 |
| Consumables | 373.01 | 8.79 | 362.60 | 9.05 |
| Monitor wafers | 36.42 | 0.86 | 34.95 | 0.87 |
| TOTAL Unyielded wafer cost | 4,243.19 | 100.00 | 4,006.46 | 100.00 |
| Line yield (%) | 92.56 | -- | 95.27 | -- |
| TOTAL Yielded wafer cost | 4,584.26 | -- | 4,205.37 | -- |
| Wafer price - 45% GPM ($) | 8,335.02 | -- | 7,646.13 | -- |

**HIGH COST PREMIUMS**

# COST PER GATE TREND

IBS

| Technology | Gates/mm$^2$ (KU) | Gate utilization (%) | Used gates/mm$^2$ (KU) | Parametric yield impact (Δ from $D_0$ yield) | Actual used gates/mm$^2$ (KU) | Gates/wafer (MU) | Wafer cost ($) | Wafer cost (Δ) | Cost per million gates ($) |
|---|---|---|---|---|---|---|---|---|---|
| 90nm | 637 | 85.7 | 546 | 97.4 | 532 | 33,830.7 | 1,357.62 | -- | 0.0401 |
| 65nm | 1,109 | 82.9 | 919 | 96.3 | 885 | 56,330.5 | 1,585.71 | 16.8 | 0.0282 |
| 40nm | 2,139 | 78.4 | 1,677 | 91.7 | 1,538 | 97,842.5 | 1,898.83 | 19.7 | 0.0194 |
| 28nm | 3,946 | 76.3 | 3,011 | 86.7 | 2,610 | 166,085.6 | 2,326.12 | 22.5 | 0.0140 |
| 20nm | 6,992 | 64.7 | 4,524 | 72.8 | 3,293 | 209,540.7 | 2,981.75 | 28.2 | 0.0142 |
| 16/14nm | 12,391 | 54.2 | 6,716 | 60.9 | 4,090 | 260,228.1 | 4,205.37 | 41.0 | 0.0162 |

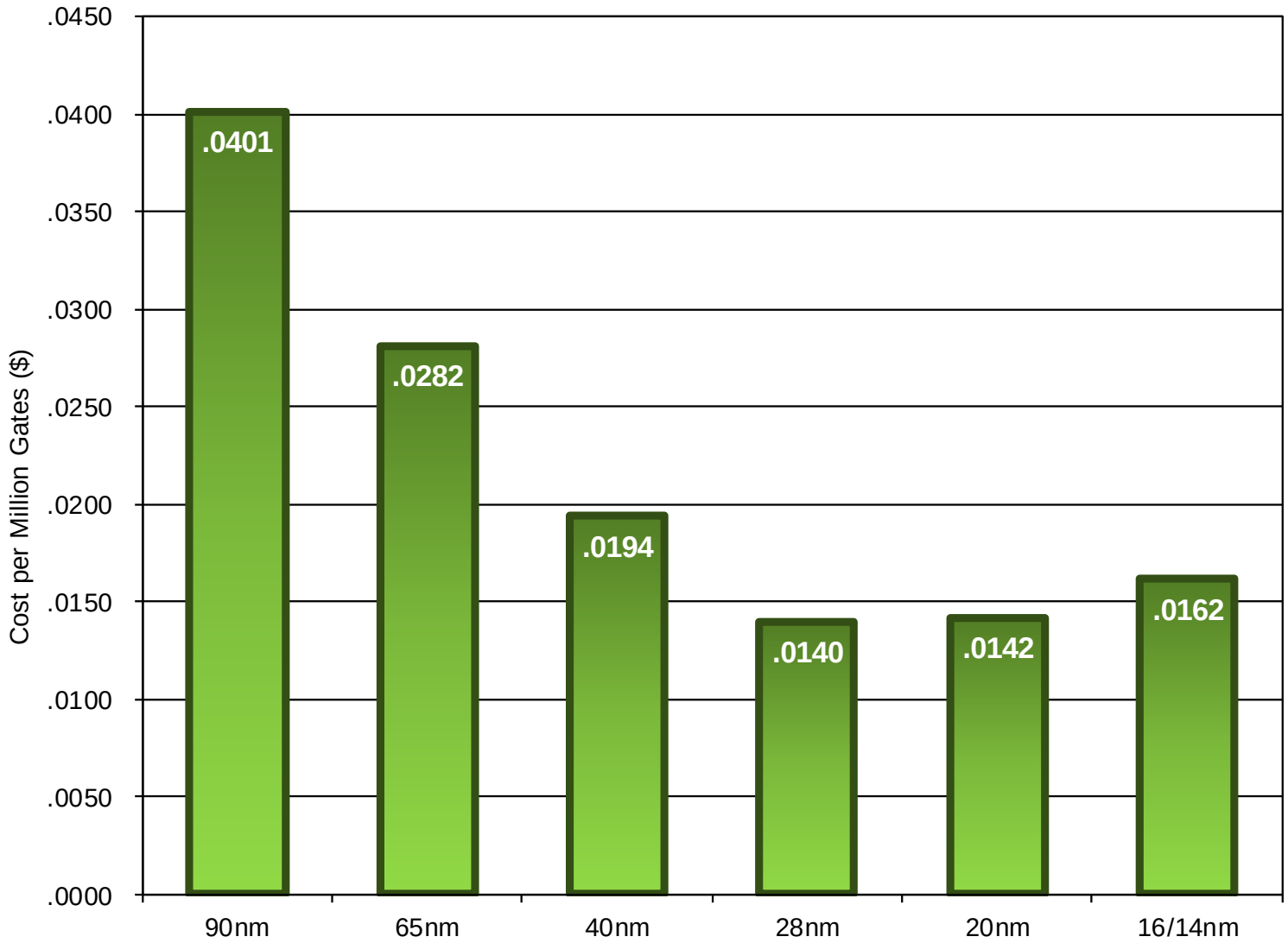
Note:

* 16/14nm is in Q4/2016. 90nm, 65nm, 40nm, 28nm, and 20nm are in two years of high volume production.

**BASED ON BULK CMOS AND FINFET**

# COST PER GATE TREND (CONTINUED)

IBS




**NEED STRONG DFM CAPABILITIES**

# KEY FACTORS IN SUPPLY CHAIN (WAFERS)

IBS

- 28nm is mature technology in 2013, with high volumes

  28nm is likely to have long lifetime, with large wafer supply

- 20nm is next logical technology node, but cost, power consumption, and performance benefits need to be demonstrated

  TSMC is projecting $5.9B in 20nm revenues in 2015, but this is probably too optimistic

  ***Low cost and low power 20nm technology is required, ie, FD SOI***

- 16/14nm in foundry volumes is planned for 2015

  Likely to be delayed to Q4/2016 or Q1/2017

  Reason is cost premiums compared to 20nm and 28nm

- Intel is planning to be in initial volume production of 14nm FinFETs in Q4/2013

  Plan is for 10nm FinFET in Q4/2015 and 7nm FinFET in Q4/2017 (450mm)

  Key challenges for foundry-fabless companies are to track Intel but also have lower cost and lower power per transistor at 14nm compared to 28nm or 20nm

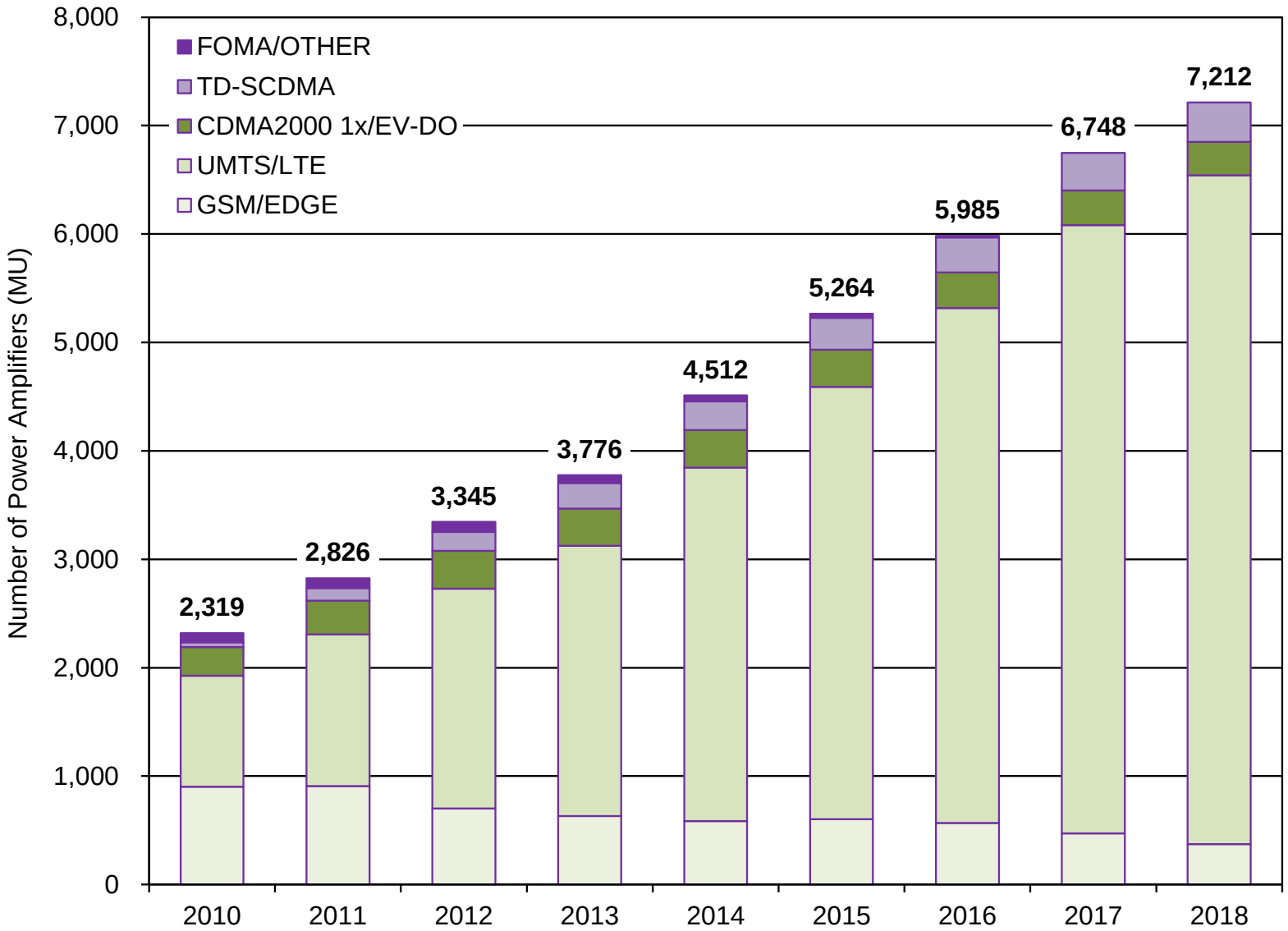
- 7nm will likely need EUV and 450mm (2017 to 2018)

  450mm fab with two EUV mask steps will cost $14B to $16B for 40K WPM

**INDICATES HIGH STRATEGIC VALUE FOR FD SOI IN LOW POWER, LOW COST PRODUCTS**

# POWER AMPLIFIER VOLUMES

IBS



# CONCLUSION

IBS

- IC market will have stronger growth in 2014 than in 2013 but will continue to be price sensitive
- China market is growing, but 90% of ICs are supplied by foreign companies

  Smartphone and tablet computer volumes are growing rapidly in China
- ***Smartphones will continue to be key driver, but with price pressures and need for low power***
- Bulk CMOS at 20nm has many technology and cost challenges

  Initial indications of high leakage and minimal area reduction over 28nm
- 16/14nm FinFET does not show significant chip area reduction over 20nm bulk CMOS

  Large wafer cost is premium
- FD SOI is attractive technology for China because of low leakage and lower cost die compared to bulk CMOS at 20nm and 16/14nm FinFETs
- FD SOI is scalable at 14nm, giving three technology nodes
- Back-biasing design expertise is not difficult to develop
- Relatively easy transition of libraries and IP from 28nm and 20nm bulk to FD SOI
- RF SOI also has good growth potential, with power amplifier market having large potential

**FD SOI SCALABILITY FROM 28nm TO 20nm TO 14nm IS COMPELLING ROADMAP FOR CHINA**